

“The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases. Preliminary Note.” By C. E. S. PHILLIPS. Communicated by Sir WILLIAM CROOKES. Received November 30,—Read December 15, 1898.

The experiments herein described were undertaken in order to ascertain what would be the action of strongly magnetised electrodes upon electrical discharge phenomena in rarefied gases, and especially upon the charged residual gas, when all external stimulation had ceased.

For this purpose an apparatus was constructed, as shown in Fig. 1, consisting of a soda-glass bulb, *B*, open at both ends for the purpose of inserting the pointed soft iron electrodes, *E*₁ and *E*₂, and with the leading tube *L* attached for connection to a Sprengel air pump.

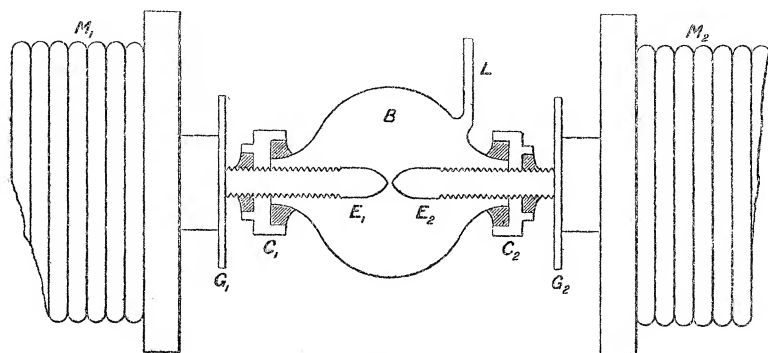


FIG. 1.

No precaution was taken to keep mercury vapour out of the bulb *B* during the experiments. Each electrode had a screw thread of suitable pitch cut upon it, in order that the brass cups *C*₁ and *C*₂, when screwed into position and sealed with cement to the glass, might serve to keep the electrodes central, to reduce the possibility of their rushing together under the influence of strong magnetic forces, and to seal air-tight the two ends of the bulb.

The poles of a large electro-magnet, *M*₁ *M*₂, were insulated from the electrodes by means of two thin glass sheets, *G*₁ *G*₂. A discharge from the secondary of an induction coil or other suitable source, could then be passed through the bulb, the exhaustion varied and the electrodes magnetised at pleasure.

Results.

A pressure was obtained within the bulb, such that cathode rays began to be freely emitted by the negative electrode, and from the

screw thread cut upon it there came a helix of rays which gave rise to the appearance of golden-green rings of fluorescence upon the inner surface of the glass vessel B. When the electrodes were magnetised these green rings twisted somewhat and moved forward, the direction of rotation depending upon the polarity of the magnet emitting the rays.

It has already been noticed* that an external magnet, placed behind the negative electrode will cause rotation of the green fluorescence upon the walls of an exhausted tube, and that the direction of motion is opposite to what it would be in the case of a wire placed at right angles to the axis of the magnet, and in which a current flowed away from the pole. In the above experiment, the rotation was only partial but agreed in direction with the results of other observers.

The bending forward of the rays is evidently dependent upon their partial rotation, because, on reversing the polarity of the magnet emitting them, the direction of their rotation was also reversed, and the bending forward still occurred. That a positively charged body, moving in a definite direction, sets up magnetic whirls in planes transverse to its path, is generally accepted, the whole effect indeed being treated as a current flowing in the same direction; and it seems only logical to conclude that were the body negatively charged, its motion would give rise to effects similar to those accompanying a flow of current in the opposite direction. From this we should expect cathode rays to behave towards a magnet just as would a wire carrying a current in the opposite direction to that in which the charged particles, constituting the rays, are supposed to be moving—a view which is borne out by experiment.

The pressure was then still further lowered, until a 3-inch spark from a 10-inch Apps induction coil was only just able to start the glow. Under these conditions irregular green patches flickered upon the inner surface of the glass; but when the electrodes were oppositely magnetised these green flecks immediately vanished, and, the resistance of the residual gas within the bulb becoming smaller, a hazy blue cloud formed between the points.

Owing to the ever varying charges upon the inner surface of the bulb and upon the electrodes themselves, it could not be ascertained whether this blue cloud tended to assume a definite geometrical form or not. It was found, however, that, after a strong stimulation of the bulb had taken place and then been stopped, the electrodes meanwhile remaining unmagnetised, on exciting the magnet, a luminous ring suddenly appeared within the bulb, between the pointed ends of the electrodes, and in a plane at right angles to the direction of the magnetic lines of force.

The ring shone brightly for a moment, when the magnet circuit was

* 'Phil. Trans,' 1879, Part II, p. 657.

“made,” and it was more sharply defined at high exhaustions: becoming in fact hazy and indefinite, if the pressure within the bulb was slightly increased.

On the other hand the rarefaction must not be carried too far, for it is necessary, in order to obtain this luminous effect, that the residual gas within the bulb should be very generally stimulated by the passage of the discharge. The following combinations were then tried:—

After stimulation, both the leading wires attached to the electrodes were removed from the secondary of the induction coil, and (*a*) insulated, (*b*) joined together and insulated, (*c*) joined together and connected to earth, (*d*) one insulated and the other connected to earth. In all these cases the ring formed equally well when the pointed ends of the electrodes were oppositely magnetised. On the other hand, as long as the points were made either both N or both S, no ring could be obtained.

In another experiment, after the exhaustion had been carried somewhat further and the bulb strongly stimulated, a second ring flashed out momentarily when the magnet circuit was completed; it formed concentrically with the smaller and more permanent ring, and appeared to be situated upon the inner surface of the glass bulb.

Observations as to the actual mode of formation of what I venture to call the primary ring, *i.e.*, the smaller one of the two, could at this stage of exhaustion be conveniently made. It appeared to emanate originally as a bright stream from between the electrodes, and then to curl rapidly round the magnetic axis, that portion most distant from the electrodes gaining upon the rest, ultimately disengaging the tail of the stream from between the points, and thus forming an equatorial circle of light within the bulb. The ring then spread out and became somewhat wider and less well defined, and as it gradually died away the glow seemed to be rotating more and more slowly until at last it flickered and vanished.

It appears, in fact, that this luminous ring spins between the electrodes from the moment it forms under the action of the magnet, the high initial velocity with which, in that case, it must be set in motion tending to keep it rotating, even after the magnetic lines have reached a maximum. The gradual expansion of the ring, which begins to take place immediately it has formed, may, according to this view, be due partly to centrifugal force, and also partly to the attraction exerted by an electrostatic charge residing upon the inner surface of the glass walls of the bulb. It is significant, too, that when the ring had all but disappeared, the sudden turning off of the magnet slightly revived the luminosity. At the instant the ring formed, the glass walls of the bulb became charged so strongly that a spark could, in some cases, be seen to pass between the outer surface of the glass and the brass cups, C_1 , C_2 , attached respectively to either electrode. It should be noticed that the ring is

generally very sensitive to variations in the charge upon the glass walls, and that touching the bulb at various places with the fingers produces vigorous movements of the glow within.

In a bulb, the diameter of which was about 3 inches, the ring threaded itself on to either of the electrodes E_1 or E_2 , when the centre of the bulb was electrically connected to the cups C_2 and C_1 respectively.

When only one electrode was magnetised, after the bulb had been stimulated, the rotation of the glow was more easily seen owing to the formation around the magnetised electrode of a wide, spiral-shaped, luminous cloud which was apparently rotating as it became more and more dim, and it was then noticed that the direction of rotation could be reversed by reversing the polarity of the magnetised electrode. No change in the effect was observed when the connections to the bulb were reversed.

The form of the electrodes was next varied, but the effects produced were mainly the same. With a pointed cathode and a concave anode the ring formed as usual, but it was observed that, whenever these relations were reversed, no ring could be obtained. Indeed, having first of all stimulated the bulb with the concave electrode negative, it was not only impossible to obtain a ring on magnetising the electrodes, but even when the connections were reversed still no ring would form until after repeated or prolonged stimulation of the bulb. Neither did a ring form when the electrodes were magnetised so that like poles faced each other—a similar result to that already observed with pointed electrodes.

It may be worth recording that when pointed electrodes were employed, the ring formed equally well, whether the bulb was stimulated by means of a Tesla oscillator, an induction coil, or a Wimshurst influence machine.

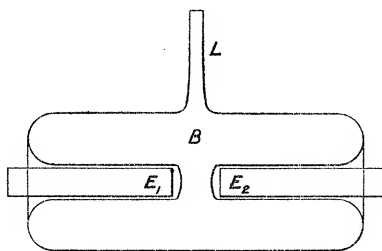


FIG. 2.

Finally, experiments were made with external magnetised electrodes, the exhausted bulb being shaped as shown in fig. 2. In this case of course, the discharge was oscillatory, and consequently the effects were not very directly comparable to those already described.

At a low pressure, however, and when the bulb was filled with a

green glow, on disconnecting the induction coil and magnetising the electrodes, a flash of white light was observed within the tube, and irregular green splashes momentarily made their appearance upon the glass.

In conclusion, I desire to offer my thanks to Dr. Silvanus P. Thompson, F.R.S., for kindly permitting me to use the Tesla apparatus at his laboratory, and for the interest he has taken in the progress of these experiments.

“Observations on the Anatomy, Physiology, and Degenerations of the Nervous System of the Bird.” By R. BOYCE and W. B. WARRINGTON. Communicated by Professor SHERRINGTON, F.R.S. Received December 7,—Read December 15, 1898.

(Abstract.)

In this research the modern methods of investigating the course of tracts and their degeneration in the central nervous system have been used. The previous literature of the subject is scanty. Bumm first gave an account of the various tracts in the brain, and the histological side has been and is still being worked out by Brandis.

Valuable information is given by Edinger in his ‘Vorlesungen,’ and quite recently the Marchi method has been used and the results obtained described by Wiener and Münzer, Wallenberg and Friedländer.

The anatomy has been studied by sections made in the three planes and stained by the Weigert and Nissl methods, and by observing the course of the degenerated fibres following various lesions, staining by Marchi’s fluid.

In the brain of the Bird the cortex of higher animals is represented by a thin pallial sheet of grey matter, forming the mesial and dorsal boundary of the narrow ventricle, and gradually losing itself on the lateral aspect of the hemisphere. Its substance is composed of oval, rather large cells, grouped into clusters, and it contains the fibres of an important tract, called by Edinger the Tr. septomesencephalicus, and by us alluded to as the pallial tract. The hemispheres themselves correspond to basal ganglia; posteriorly they expand laterally into the large occipital lobes. Their substance contains cells resembling those found in the pallium, and which cannot be differentiated distinctly into definite regions.

The hemispheres are connected with the thalamus by a constriction of their substance, forming an isthmus on either side, from which the thalamus in transverse section is seen suspended as a triangular shaped body.